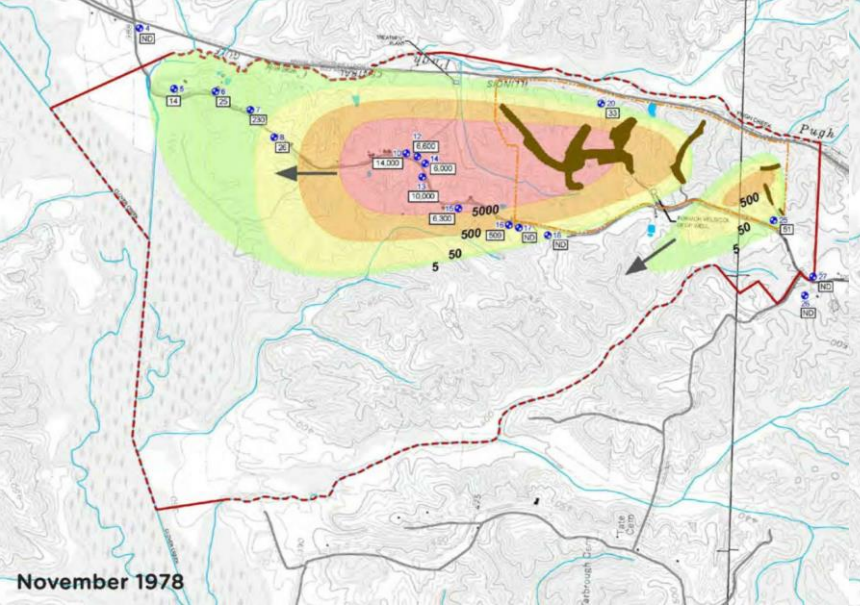
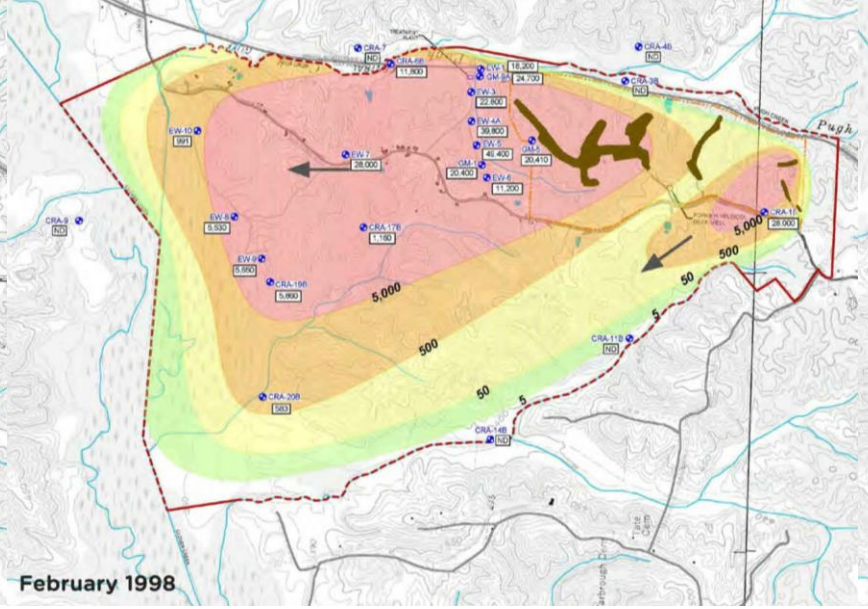
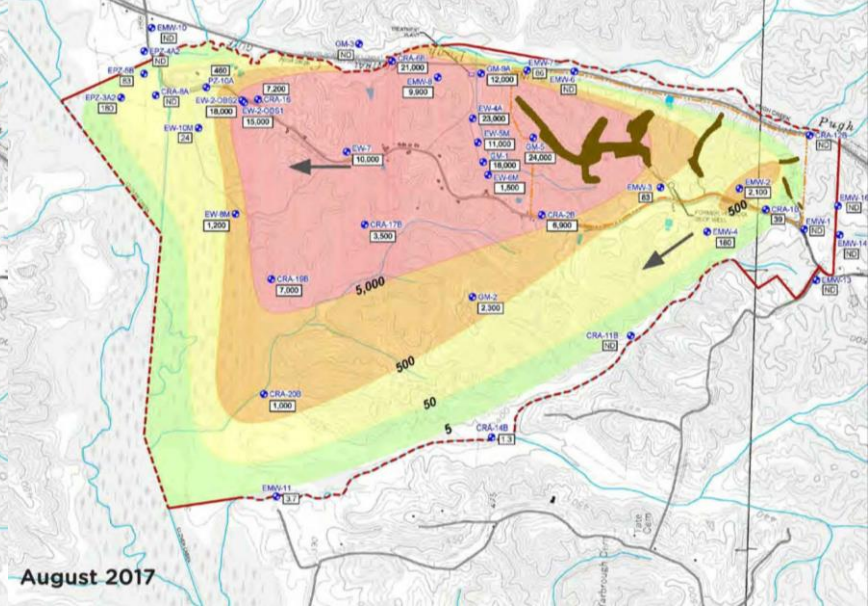






FIFTY-YEAR PLUME RESPONSE TO SUCCESSIVE REMEDIAL MEASURES EMPLOYED WITH AN EVOLVING SITE CONCEPTUAL MODEL

47th Annual Environmental Show of the South

May 17, 2018

David Heidlauf, CPG

RAMBOLL

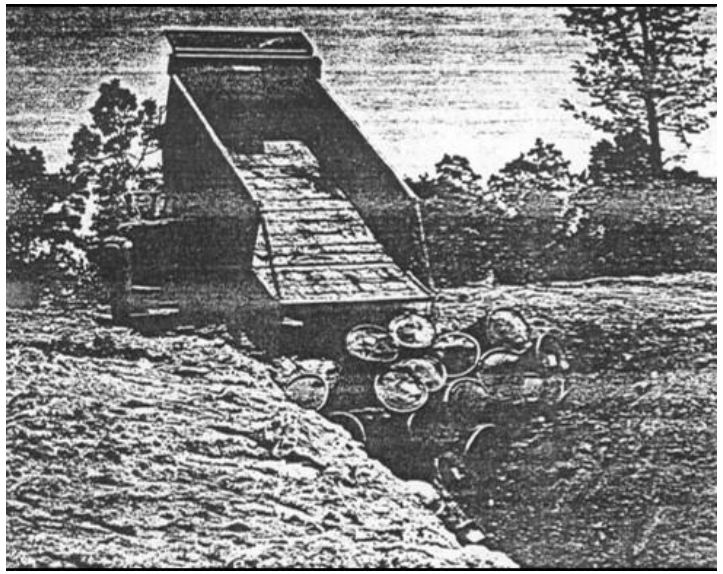
SITE ORIGIN

- 1963 lower Mississippi River fish kill traced back to pesticide plant
- Plant forced to change waste disposal method
- Considered Gulf of Mexico disposal, incineration and land disposal options
- Plant made the following justification statement for land disposal

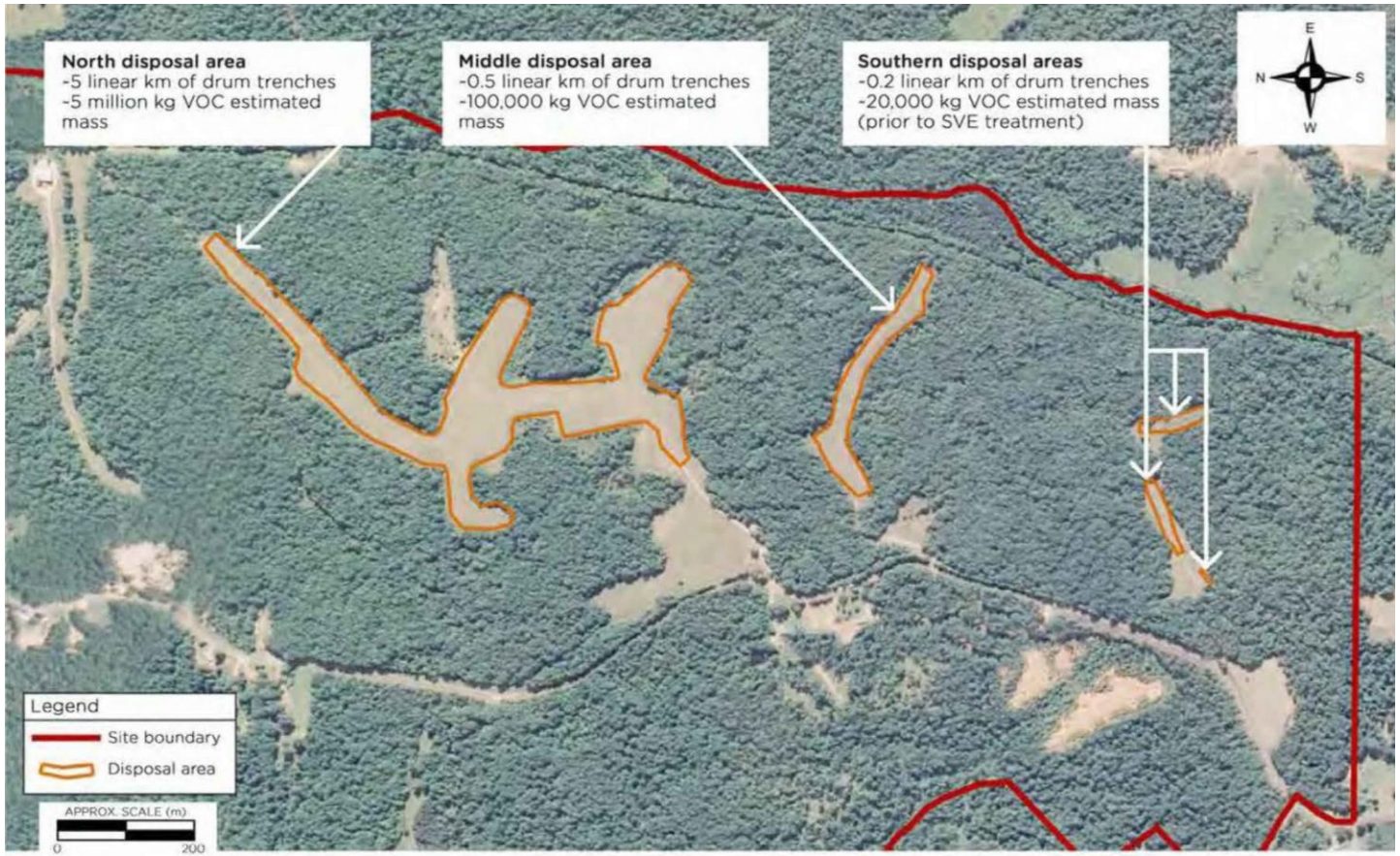
"Shallow burial of toxic waste is a time-honored procedure and it does not pose any real or immediate hazard to public safety."

RAMBOLL

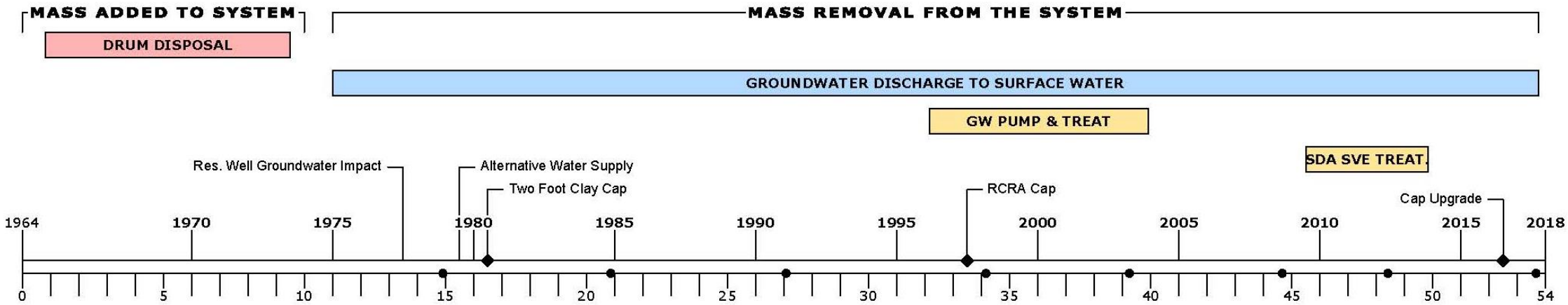
PESTICIDE WASTE DISPOSAL FROM 1964–1973



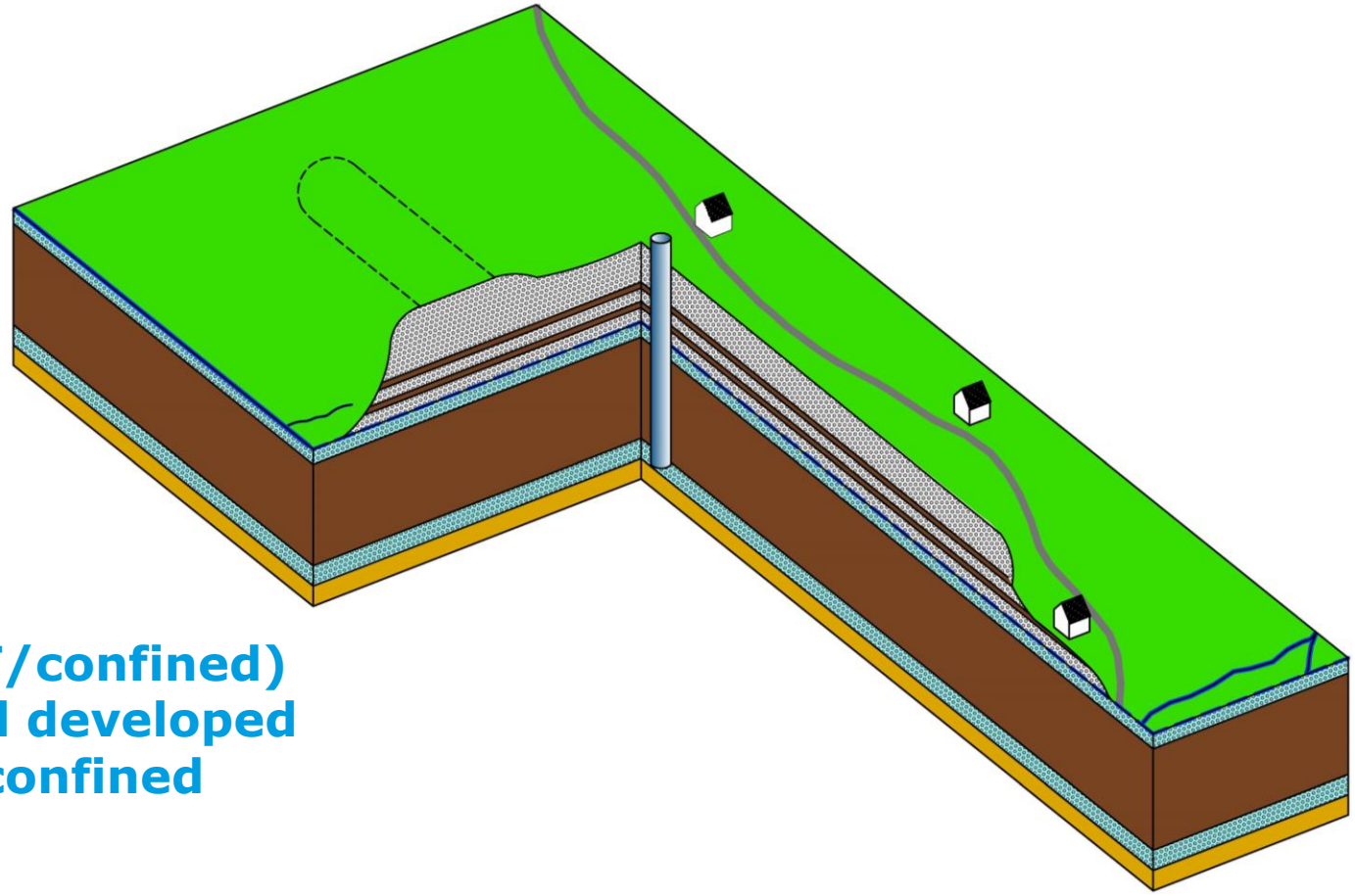
WASTE DISPOSAL AREAS



SITE TIMELINE



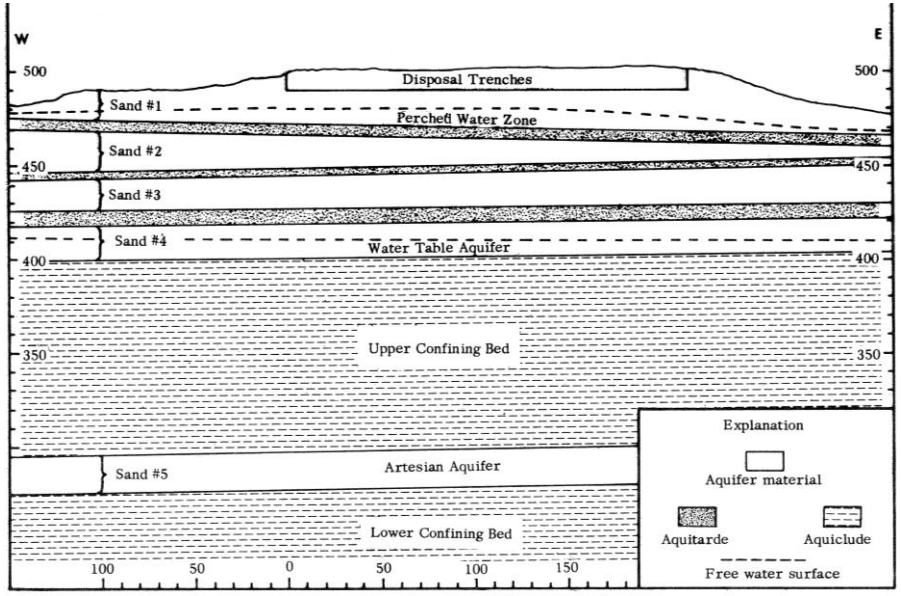
SITE CONCEPTUAL MODEL – 1964 SITE DEVELOPMENT

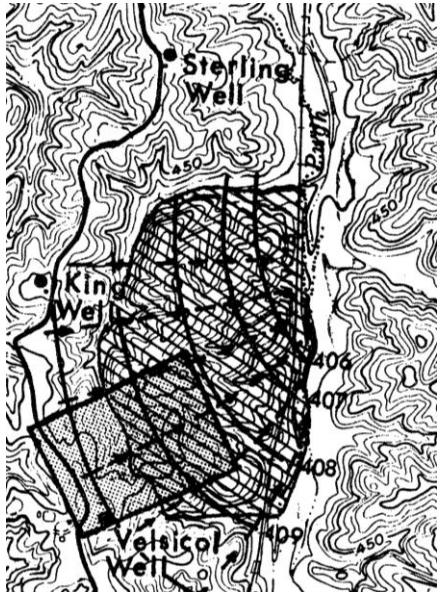


Two aquifer (WT/confined) layer cake model developed from one deep, confined aquifer well

1967 USGS STUDY

- Evaluated the potential for pesticide groundwater contamination
- Stratigraphic information from vadose zone borings and one deep site well
- Easterly groundwater flow direction based on perched well data





1967 USGS STUDY – KEY FINDINGS

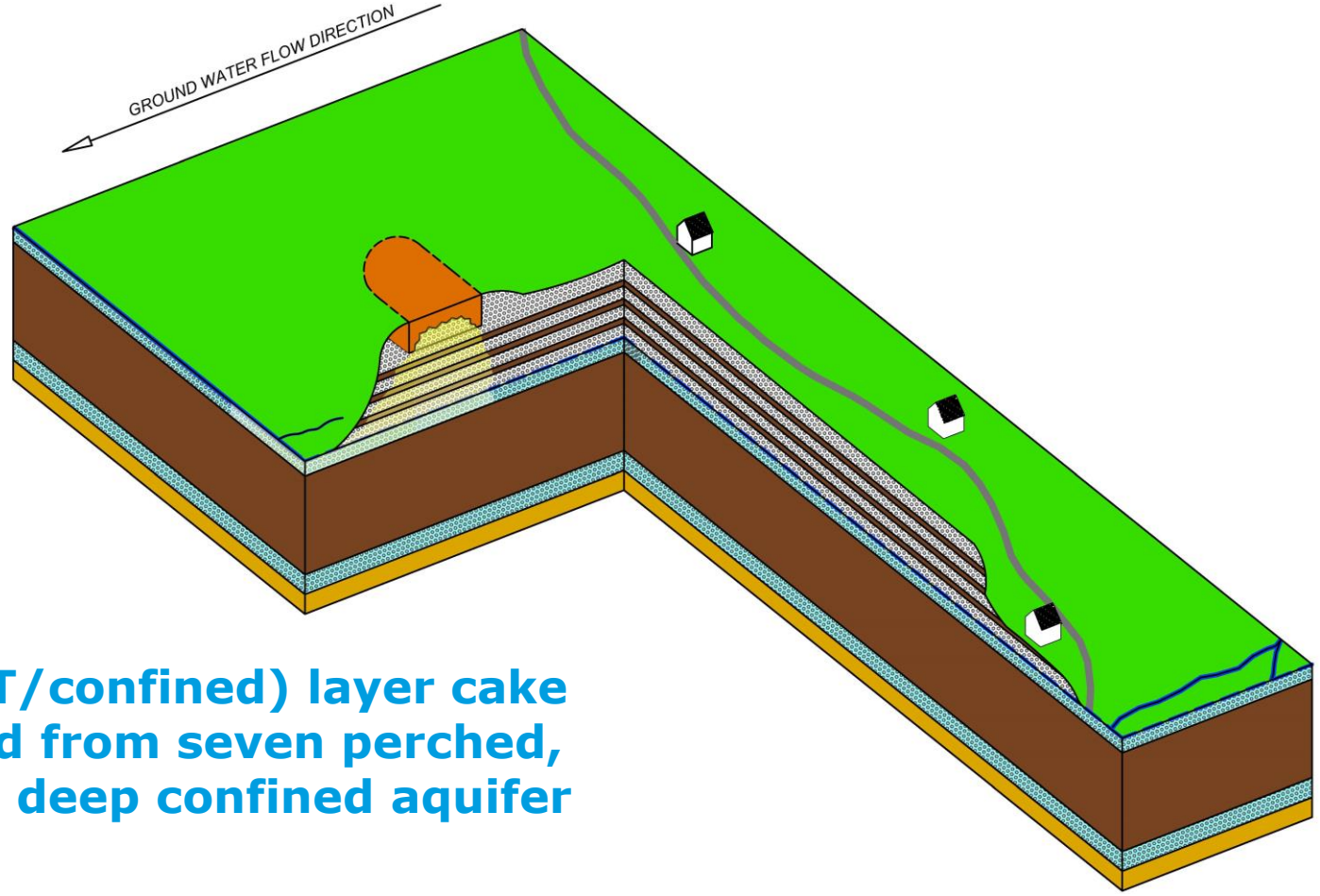
"Measurement of water levels in observation wells indicates that the water table slopes to the east."

"All neighborhood wells are located either upgradient or perpendicular to the gradient from the disposal site."

"There is, therefore, no possibility for any existing water-table wells to produce contaminated water."

RAMBOLL

SITE CONCEPTUAL MODEL – 1967 SITE OPERATIONS

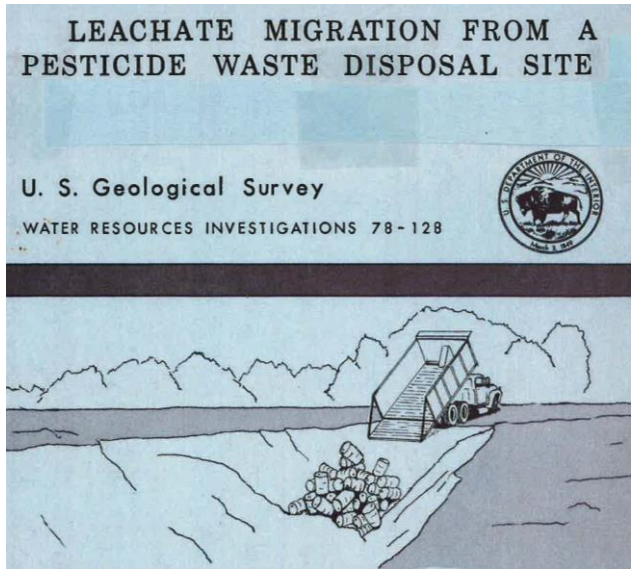


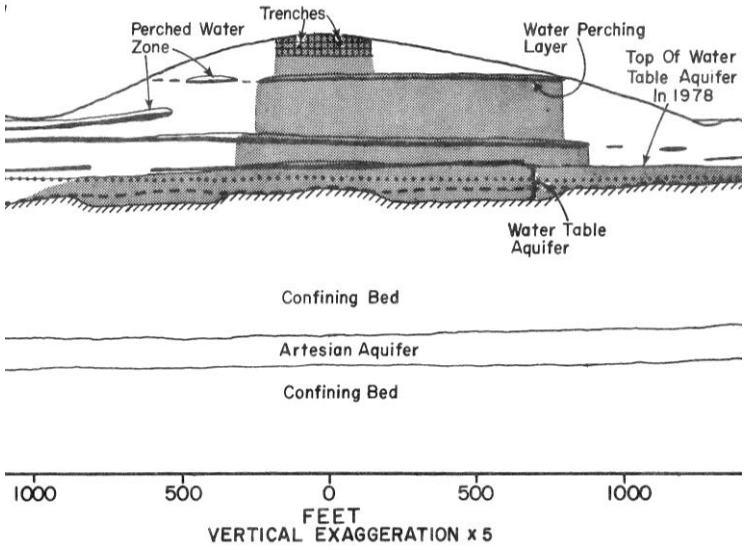
Two aquifer (WT/confined) layer cake model developed from seven perched, one WT and one deep confined aquifer wells

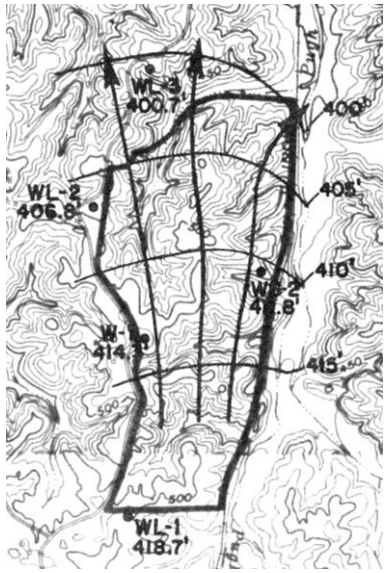
RAMBOLL

1978 USGS STUDY

- Evaluation of the extent and direction of leachate migration from the pesticide waste disposal site – (analytical testing for pesticides only)
- Hydrostratigraphic information from 5 WT and one deep (confined) well







1978 USGS STUDY – KEY FINDINGS

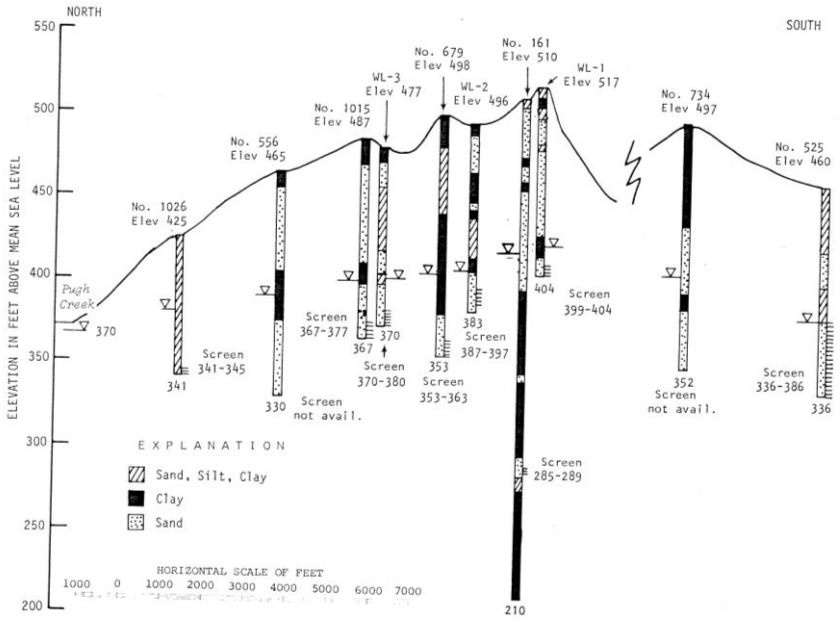
"Measurements of water levels in observation wells indicate groundwater moves toward the north and northwest."

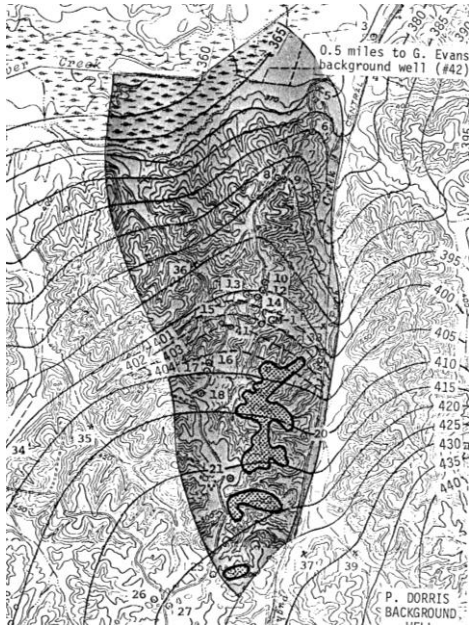
"Several wells used for domestic water supplies are north and northwest of the disposal tract and are in the inferred path of leachate as it moves under natural gradients."

RAMBOLL

1979 RESPONSIBLE PARTY (RP) CONTRACTOR STUDY

- Developed an accurate water table contour map – northerly GW flow
- Derived hydrostratigraphic information from residential wells, installed WT monitoring wells and from WT aquifer pump tests.





1979 RP CONTRACTORS STUDY – KEY FINDINGS

"Non-aqueous phase liquids (NAPLs) are present throughout the vadose zone of the disposal site."

"Significant groundwater contaminants are carbon tetrachloride and chloroform."

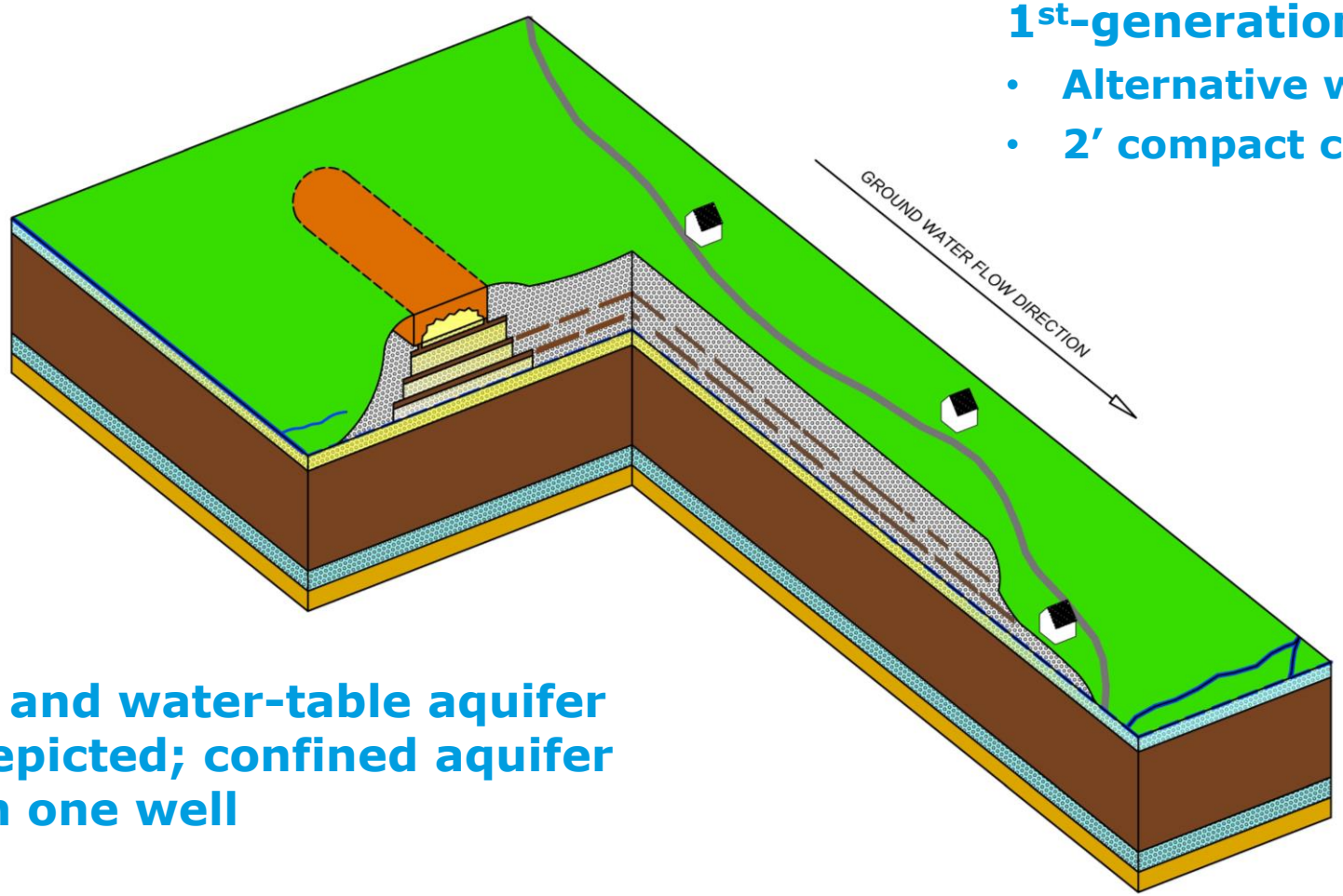
"Monitoring wells should not be installed in the artesian aquifer. The confining geologic formation protects that aquifer. Monitoring wells installed into this aquifer offer a potential avenue for contamination."

RAMBOLL

SITE CONCEPTUAL MODEL 1978–1979 POST CLOSURE

1st-generation remedy 79-80

- Alternative water supply
- 2’ compact clay LF caps



Vadose zone and water-table aquifer accurately depicted; confined aquifer still based on one well

RAMBOLL

1991 RP CONTRACTOR REMEDIAL INVESTIGATION (RI)

- Multimedia nature and extent contaminant evaluation
- Collected hydrostratigraphic information using hollow-stem auger and mud-rotary drilled boreholes/wells
- Mud-rotary was used for deeper boreholes/wells. Rig geologists logged mud-return cuttings to describe stratigraphy. They unknowingly drilled through the intermediate clay aquitard, which was logged as sand
- SCM revised to a single aquifer system based on RI logged wells
- Groundwater ingestion/inhalation showering cancer risk exceeded **unity**

RAMBOLL

1991 RP CONTRACTOR RI – KEY FINDINGS

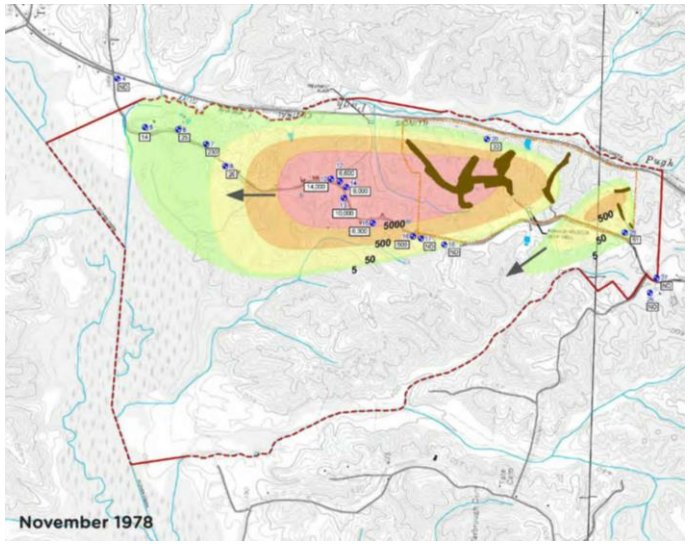
"Confining clay was not encountered to a depth of 223 ft bgs (279 ft amsl) at boring/well 1A."

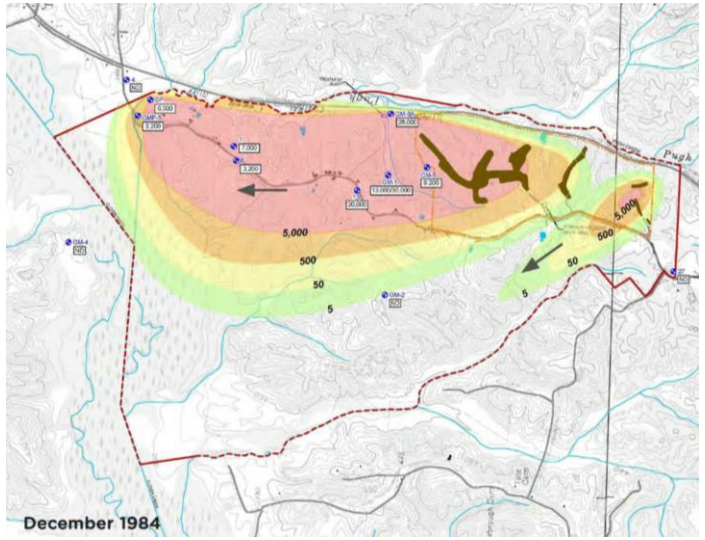
"It became apparent that confining clay units beneath the study area are discontinuous and occur over a wide range of elevations."

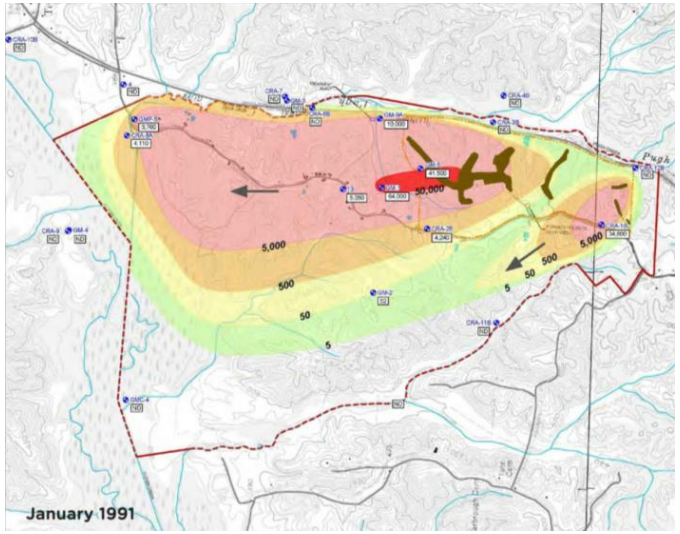
"The hydrogeological investigation has shown that one hydrostratigraphic unit exists beneath the site. The aquifer consists of a fine sand with discontinuous layers and lenses of clay."

RAMBOLL

PHASE 1 – PLUME DEVELOPMENT 1964–1991

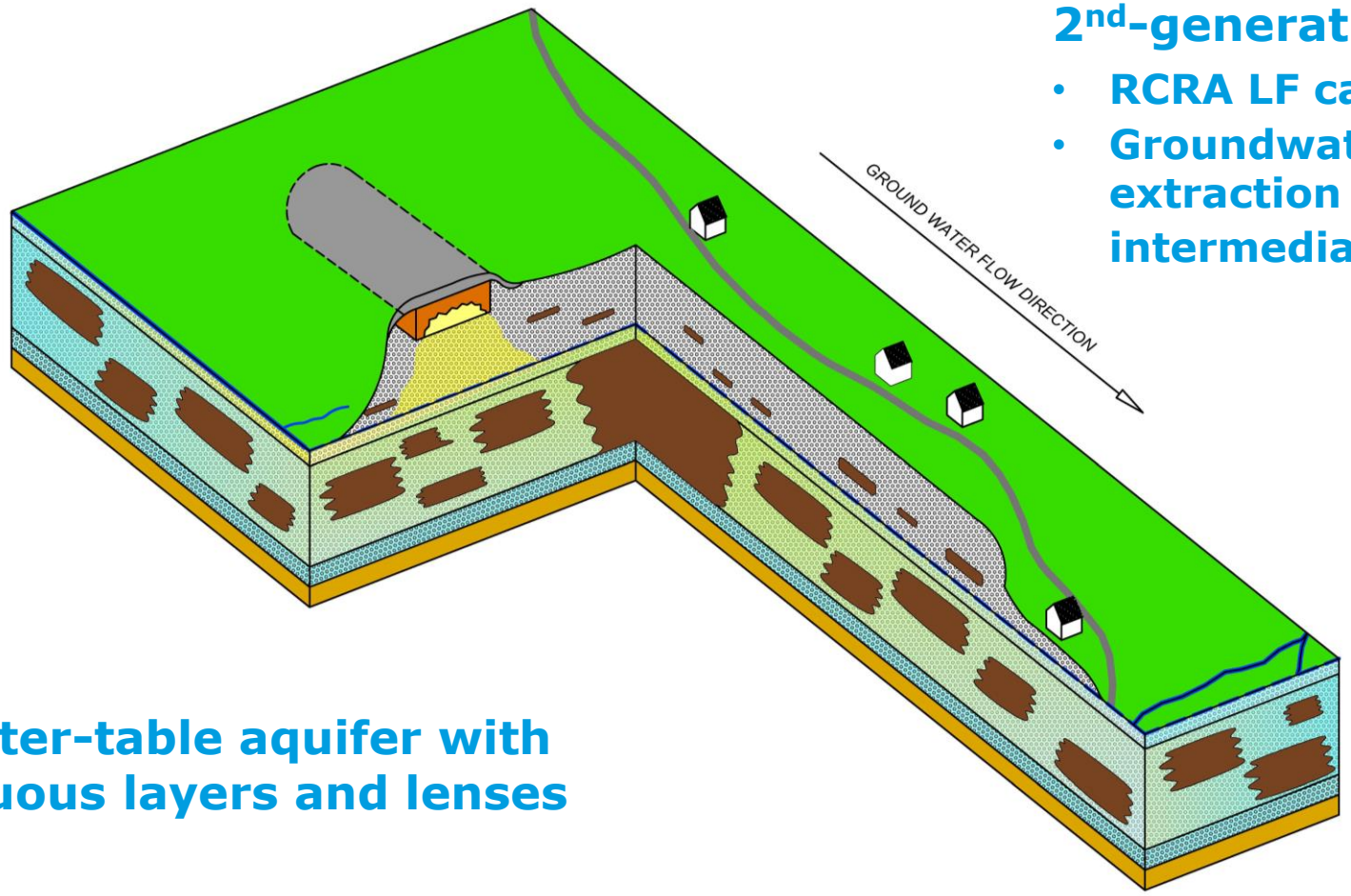






Carbon tetrachloride concentration: > 50,000 µg/L | 5,000-50,000 µg/L | 500-5,000 µg/L | 50-500 µg/L | 5-50 µg/L

SITE CONCEPTUAL MODEL – 1991 RI



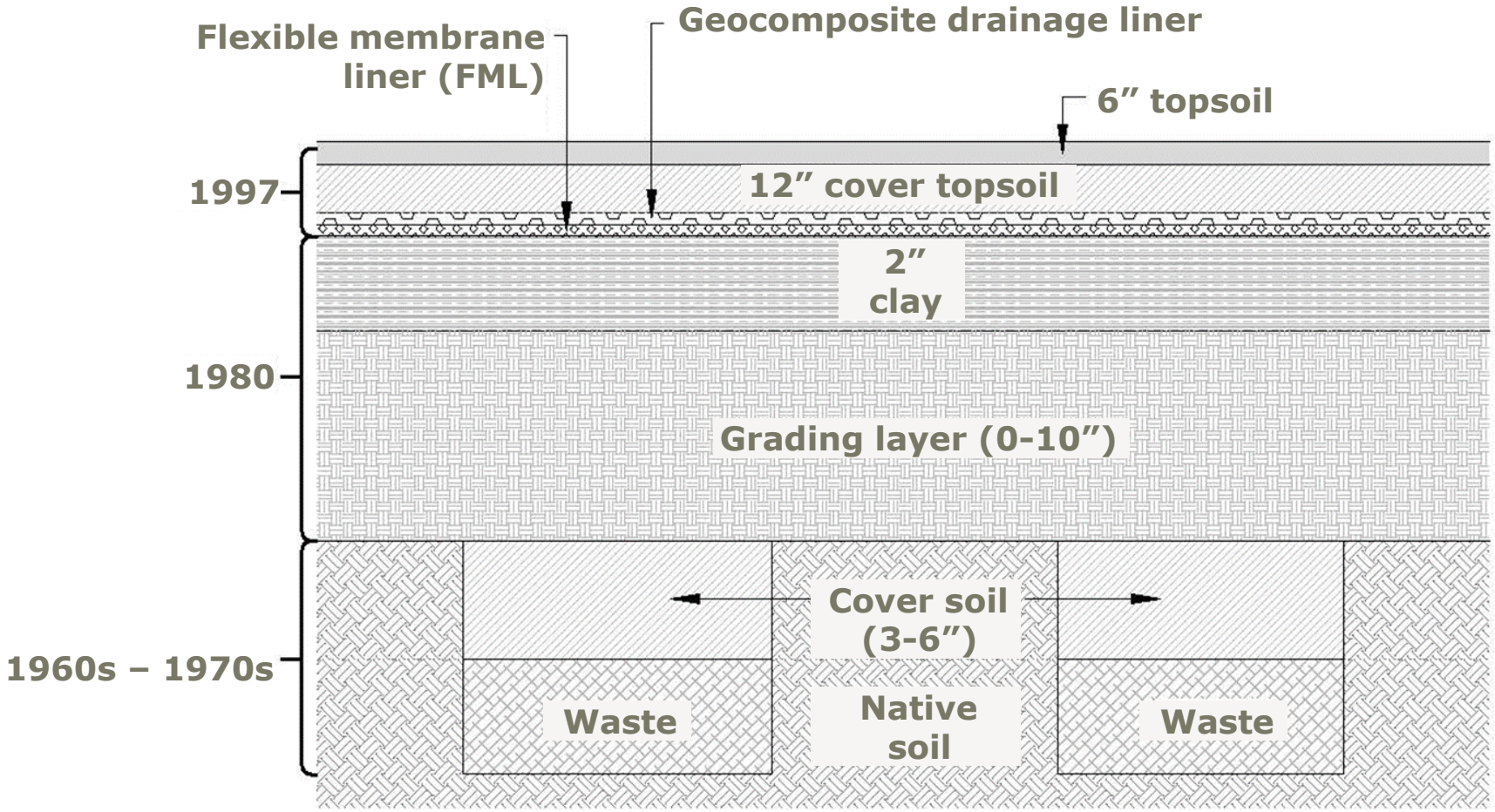
2nd-generation remedy 97-03

- RCRA LF cap upgrades
- Groundwater pump & treat extraction wells breached intermediate aquitard

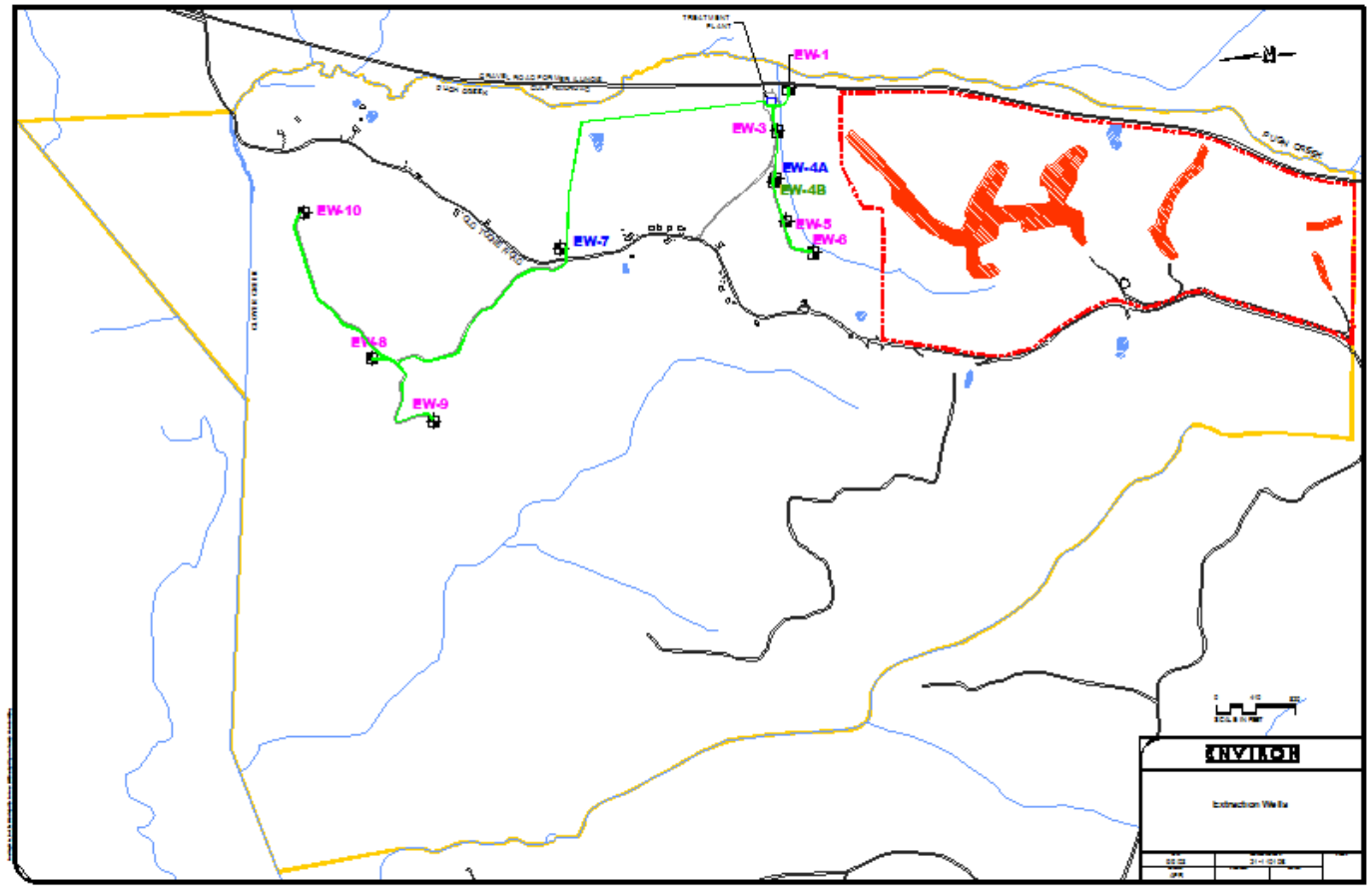
Single water-table aquifer with discontinuous layers and lenses of clay

RAMBOLL

SECOND-GENERATION RCRA CAP CONCEPTUAL SCHEMATIC



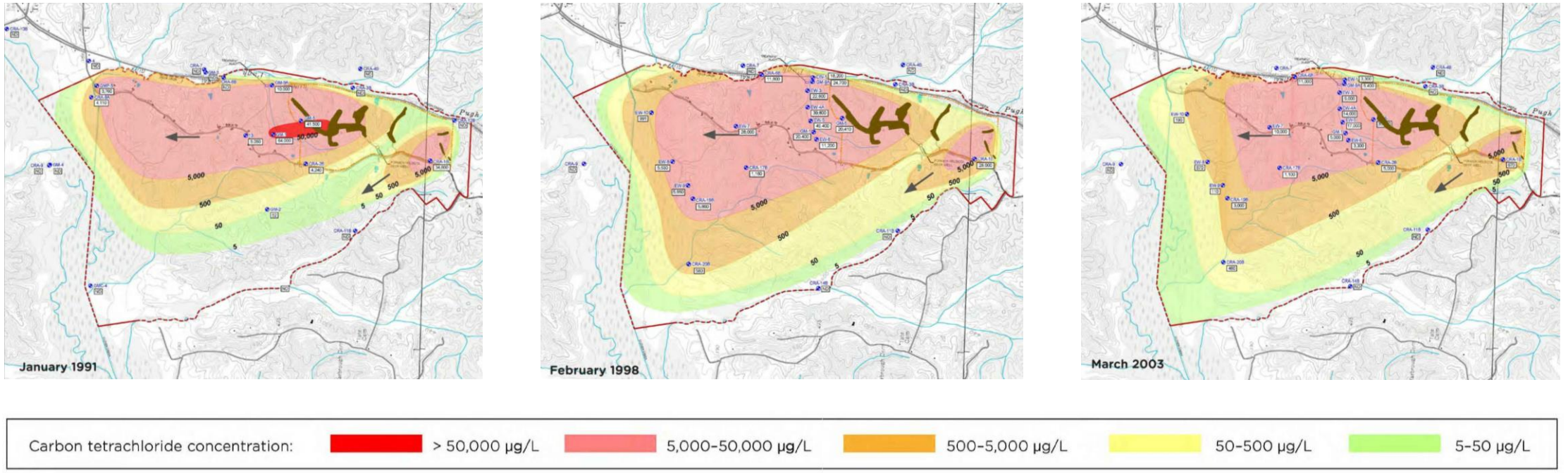
PUMP & TREAT 1997–2003



PUMP & TREAT 1997–2003

- Ten extraction wells
- Air stripping & GAC
- GAC off-gas treatment
- Treated ~772,000,000 gal
- Removed ~110,000 lbs VOCs
- Hydraulic capacity: 525 GPM
- Operated at 220 GPM (02/03)
  (~50 % of target rate)

PHASE 2 – PUMP & TREAT 1997–2003



2006 TRUST CONTRACTOR SECOND 5-YEAR REVIEW STUDY

- Multimedia nature and extent contaminant evaluation
- Evaluated the hydraulic performance of the GW pump and treat system
- Collected hydrostratigraphic information from pump tests, borehole geophysics of existing wells and stratigraphic borings completed using sonic drilling methods
- Supported USEPA's remedy failure determination and update to the site's groundwater flow model

RAMBOLL

2006 SECOND 5-YEAR REVIEW – KEY FINDINGS

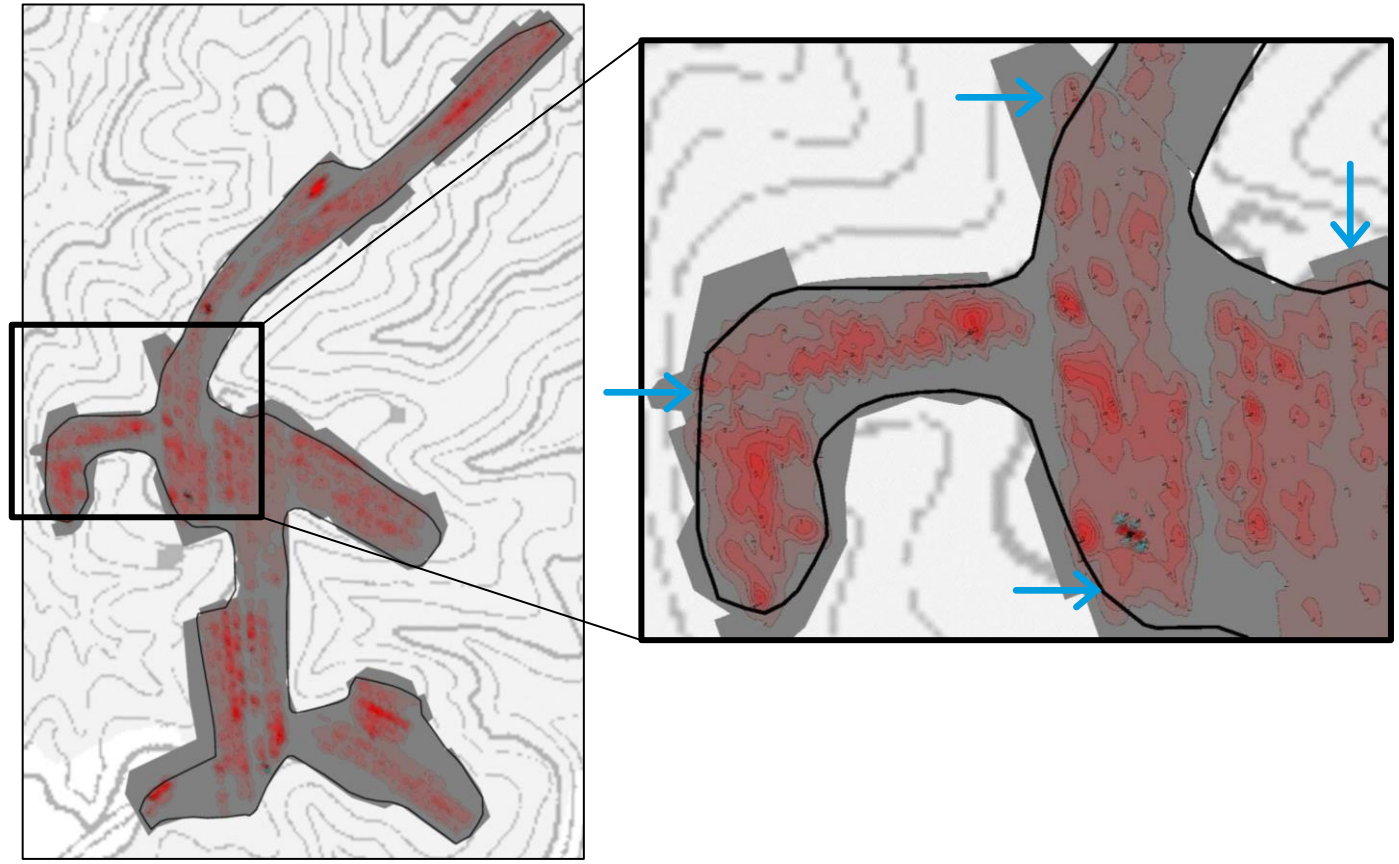
"This five-year review has concluded that the components of the remedies for the site are not functioning as intended and that the remedies are not protective of human health and the environment."

"As a result of this (performance evaluation) and subsequent evaluations, it was determined that the site had a dual versus single aquifer system, which had appreciable negative impacts on the performance of the groundwater extraction and treatment system."

RAMBOLL

EM-31 GEOPHYSICAL TRENCH MAPPING

- **3+ miles** of drum trenches mapped
- Some trenches extended beyond edge of cap



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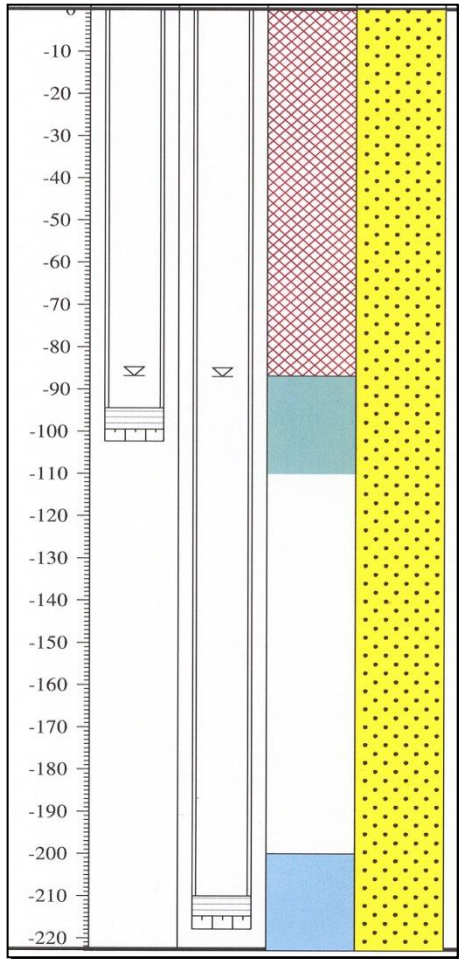
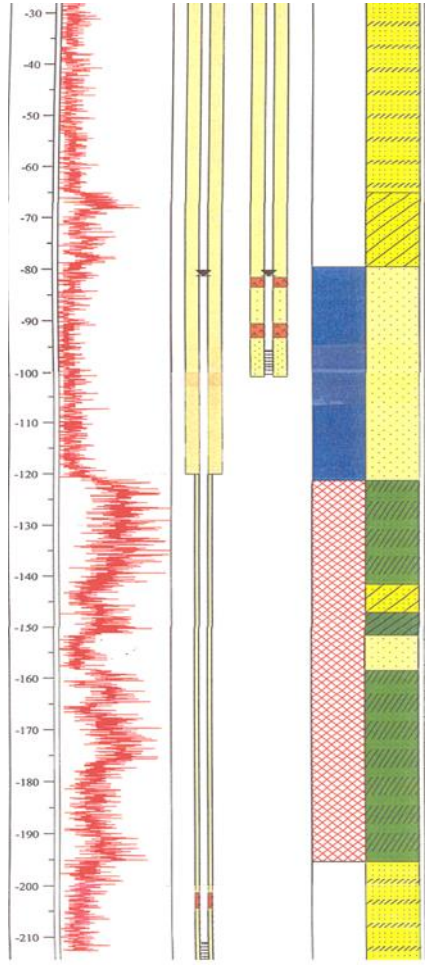
SONIC DRILLED STRATIGRAPHIC BORINGS

WELL NEST 1A/1B

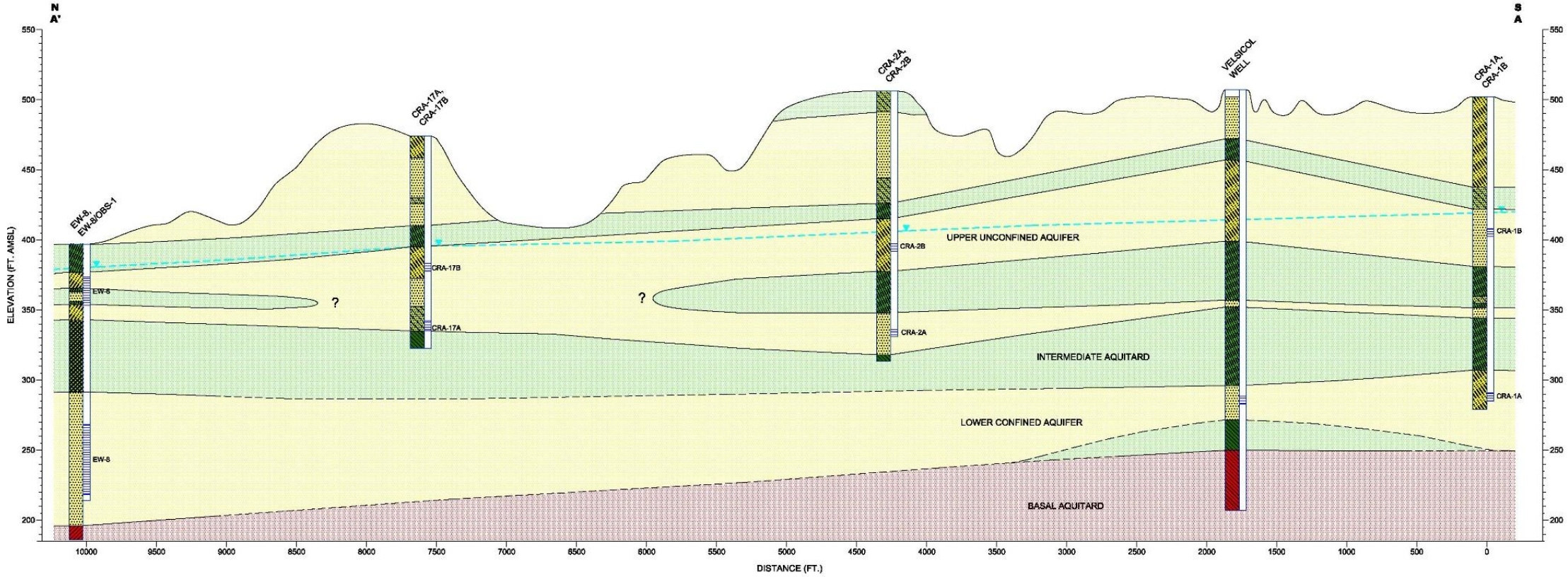


RI	Drilling method	2nd 5-yr
Vadose zone	Hollow-Stem-Auger	Vadose zone
		WT aquifer
WT aquifer	Mud Rotary	Intermediate aquitard
		Leaky confined aquifer

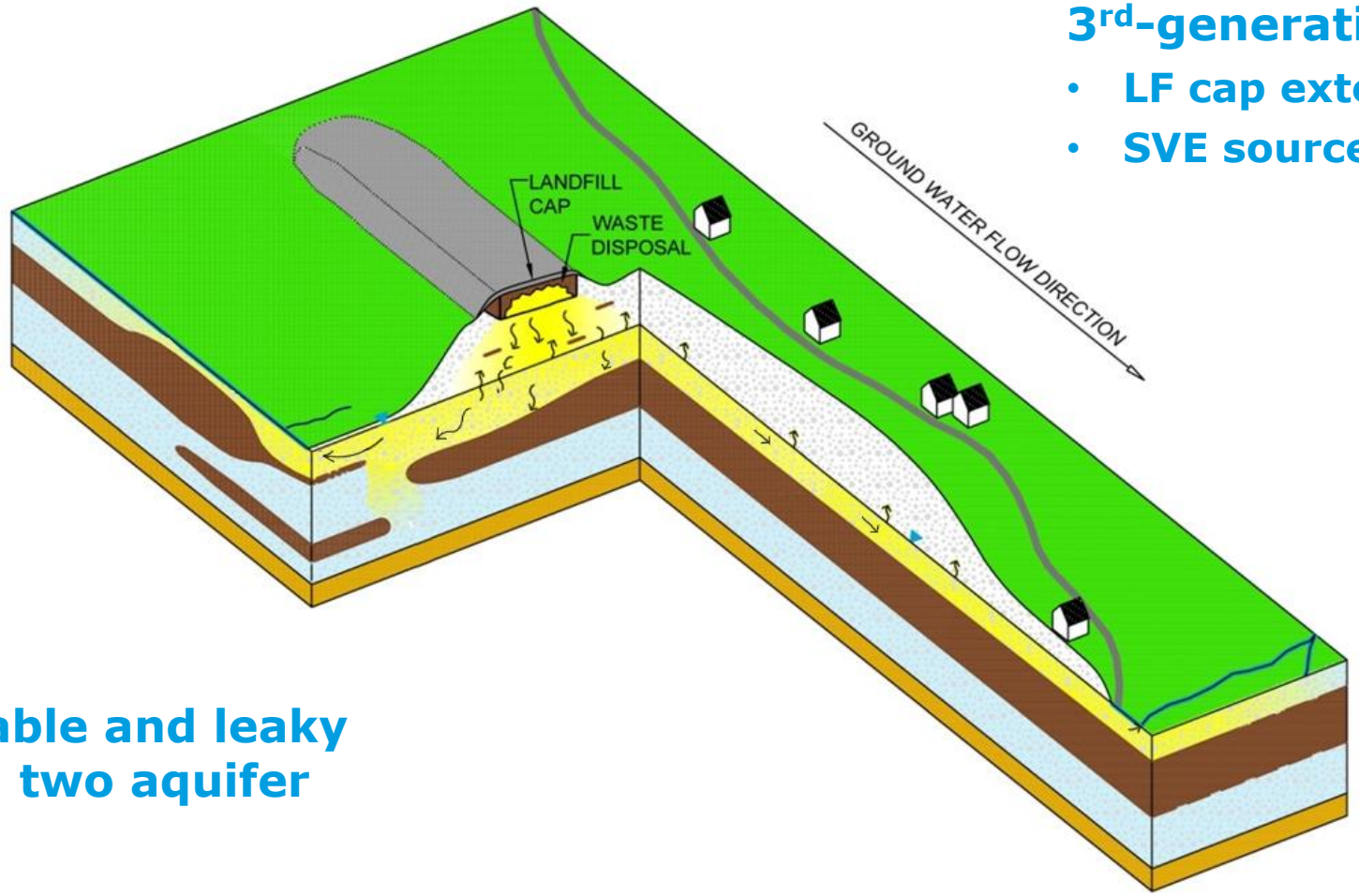


RAMBOLL

SECOND 5-YEAR HYDROSTRATIGRAPHIC CROSS SECTION



SITE CONCEPTUAL MODEL – 2ND 5-YEAR REVIEW



3rd-generation remedy 09-pres

- **LF cap extensions**
- **SVE source area treatment**

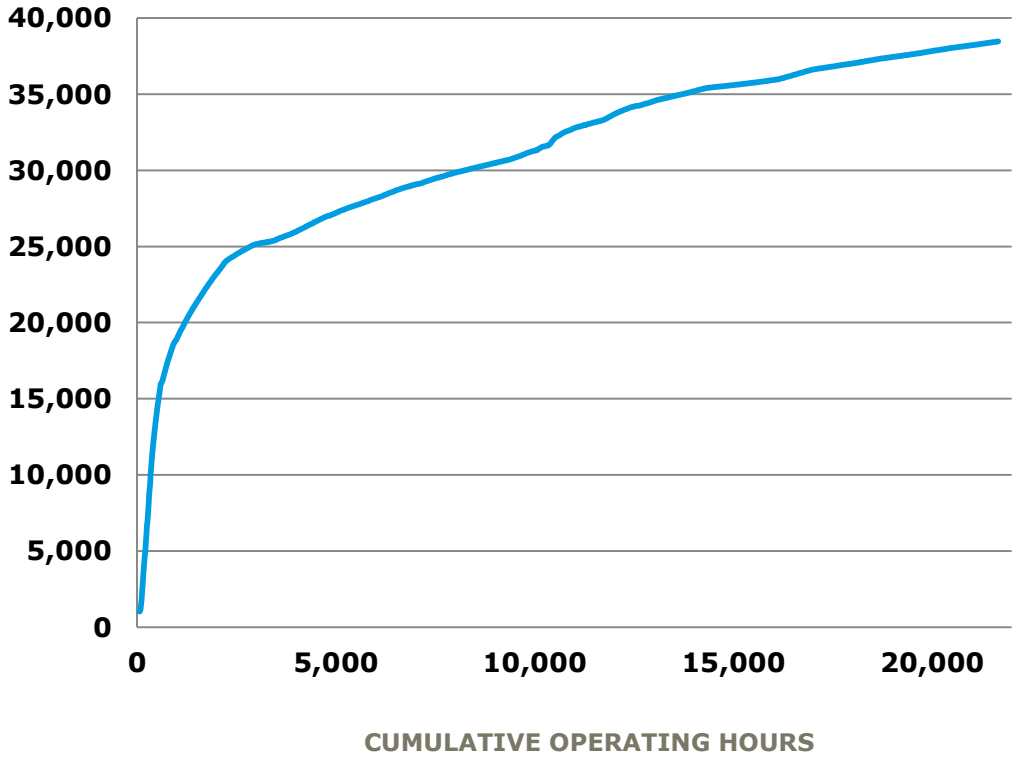
Water-table and leaky confined two aquifer system

RAMBOLL

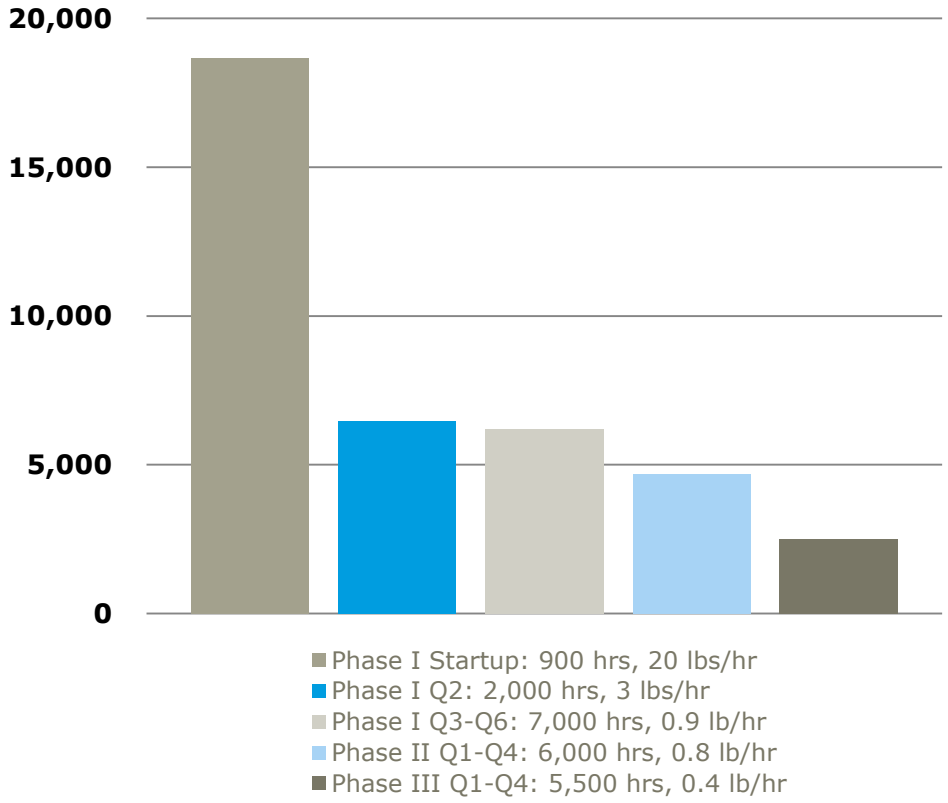
SDA SVE PILOT TEST REMEDIATION 2009–2013

RAMBOLL

SDA SVE PILOT TEST PERFORMANCE RESULTS



Mass of VOCs removed (lbs)



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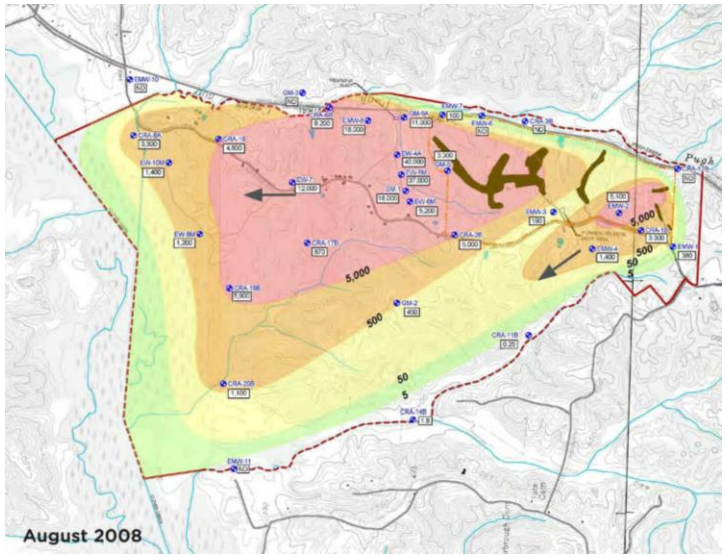
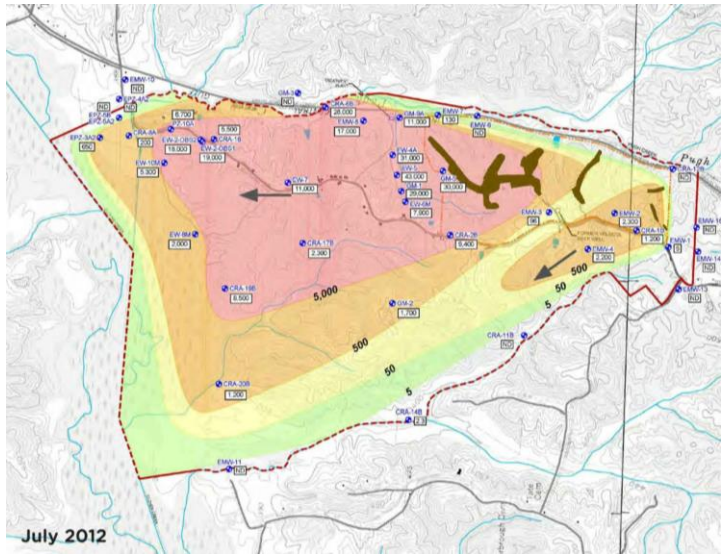
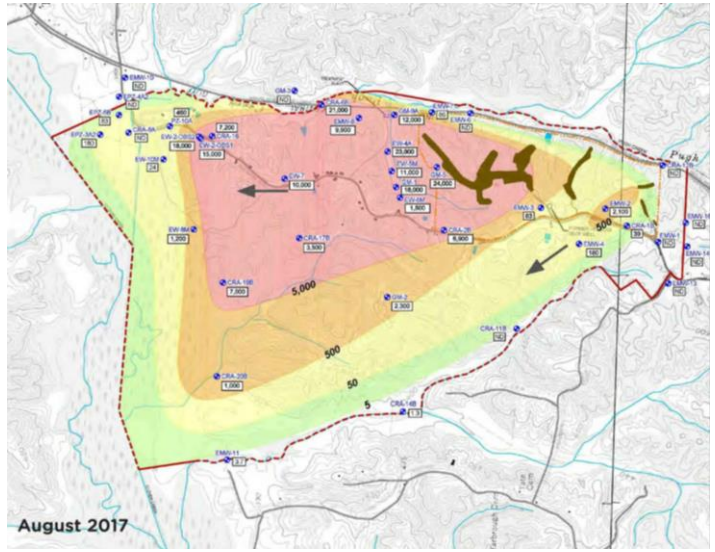
LANDFILL CAP UPGRADES 2015–2016

PHASE 3 – SDA SVE REMEDIATION PLUME IMPACT 2008–2017



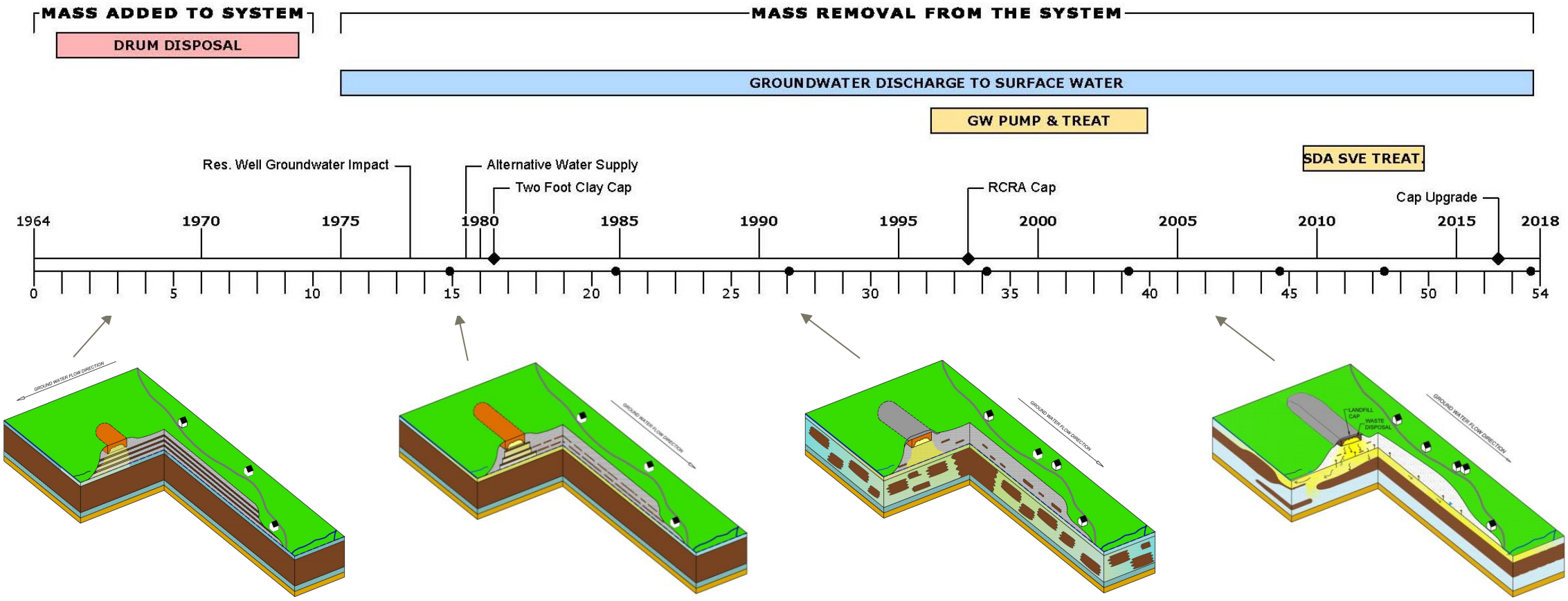




Carbon tetrachloride concentration: > 50,000 µg/L | 5,000-50,000 µg/L | 500-5,000 µg/L | 50-500 µg/L | 5-50 µg/L

SUMMARY & CONCLUSIONS

SITE CONCEPTUAL MODEL DEVELOPMENT TIMELINE



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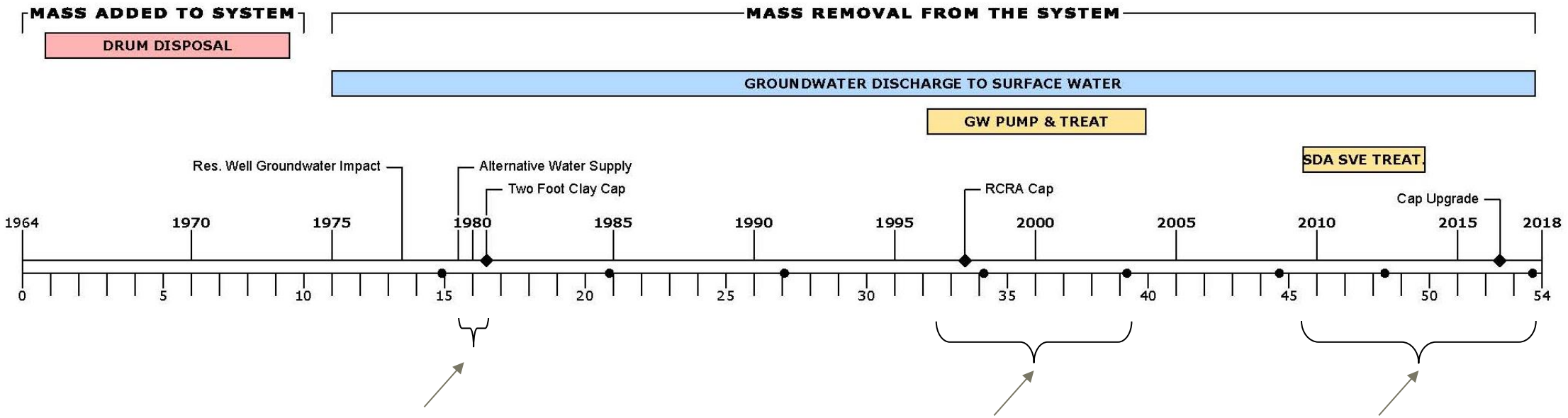
SITE REMEDIATION TIMELINE



1st-generation remedy

- Water line
- Two foot clay cap

2nd-generation remedy

- Pump and treat
- RCRA cap

3rd-generation remedy

- Cap upgrade
- Soil vapor extraction
- Groundwater - TBD

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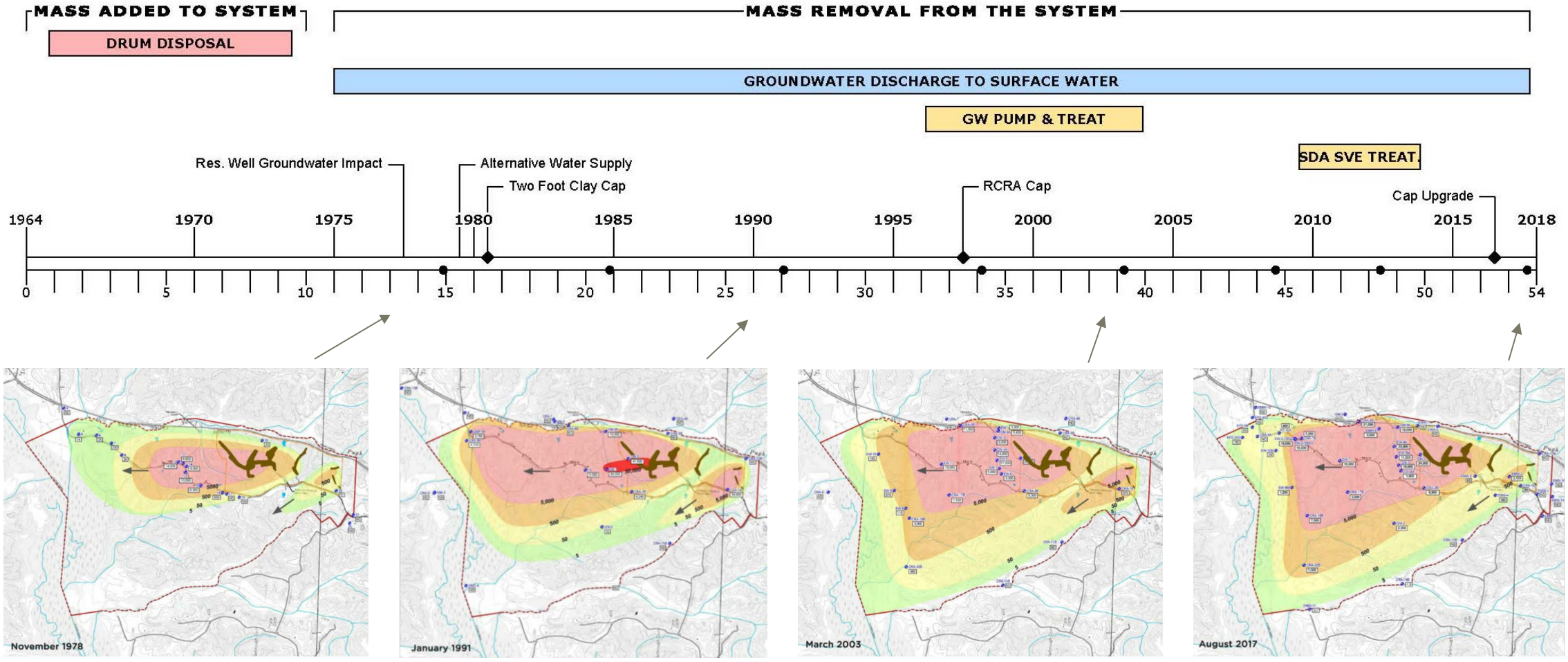
SITE PLUME EVOLUTION TIMELINE



THANK YOU

The Environmental Bankruptcy Trust

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And many others

RAMBOLL

QUESTIONS?

The original inhabitants of this land had a saying – "Every time you take something from the Earth, you must give something back."